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Dutch system of flood control an engineering marvel

By John McQuaid, Staff writer

TER HEIJDE, NETHERLANDS -The North Sea's furious winters can kick up storm surges more than 13 feet high - a lethal threat to a country where millions live below sea level, some as much as 22 feet down. And the Dutch have devised a peerless system of flood defenses - one of the world's engineering marvels - to keep that water out.

Giant barriers straddle ocean inlets, their gates poised to slam shut to repel the invading sea. Massive earthen dams run for miles, blocking off vast areas once open to the North Sea, now converted to freshwater lakes and new living space.

Those are among the master strokes. But the Dutch system is also noted for its subtlety.

The only thing lying between the tiny red-roofed village of Ter Heijde and the sea, a scant 200 yards away, is a big pile of sand.

It's no ordinary dune, however. Monitored and maintained with obsessive care, it's built to absorb pounding blows from ocean waves. It may erode, requiring repair, but it won't fall down. It's engineered to fail less than once every 10,000 years, making it 50 times safer than the New Orleans levees were supposed to be before Hurricane Katrina overwhelmed them.

But authorities aren't complacent about those numbers. Concerned about projected sea level rise, the government is studying how to further fortify the dune. "It's adequate, but we do know we will need more protection for the future," said Ter Heijde native Jacqueline Voois. "Growing up here, you learn you can't trust the sea."

The Netherlands' flood defenses - a sculpted landscape of dunes, dikes, dams, barriers, sluices and pumps designed to repel the twin threats of ocean storm surges and river flooding - are light years ahead of the New Orleans area's busted-up levee system.

As American policymakers and the Army Corps of Engineers study how to rebuild the levees to protect against a Category 5 hurricane, Dutch engineers say they can learn a lot from the Dutch model, where all elements - from structural engineering to long-term policymaking - fit seamlessly together.

"Your levee system doesn't appear to have been designed as a system. It's designed in a very haphazard way. One structure built one way, one built another," said Jurjen Battjes, a professor emeritus of engineering at the Technical University of Delft and a member of the American Society of Civil Engineers team investigating the New Orleans levees.

"They can move vehicles on Mars. Why should your system fail because of a wall collapsing or because an operator left the pumping station?"

State to look closely

There was a time when New Orleans led the world in flood control and the Netherlands looked west for guidance, importing the huge screw pumps designed by Albert Baldwin Wood that had drained low-lying areas and greatly expanded New Orleans' habitable turf. Today, the Dutch system offers a trove of examples, from policy ideas to engineering fixes, that could be useful to New Orleans. Indeed, U.S. Sen. Mary Landrieu next month will lead a delegation of Louisiana officials and congressional colleagues to the Netherlands to study them.

Like New Orleans, which built up its river levees after the 1927 flood and its hurricane levees after Betsy in 1965, the Dutch system has been forged in disaster. But the Dutch have a lot more disaster experience, and it shows.

For the past 1,000 years they have sculpted and resculpted their landscape to repel floods, only to see it repeatedly inundated - most recently by a 1953 North Sea storm surge that killed more than 1,800 people. Each time, they have rebuilt bigger, better and with greater sophistication. Flood protection is the number one national priority, and that is reflected not only in dikes and barriers but in politics, budgets and the concerns of everyday citizens.

Their philosophy, shaped by centuries of combating floods, is to fight water - but also to accommodate it rather than just containing it, preserving natural flows where possible. "There's one important lesson we've learned as Dutch - we're fighting a heroic fight against nature, the sea and the rivers," said Ted Sluiter, a spokesman for the giant Eastern Schelde storm surge barrier. "But if you fight nature, nature is going to strike back. Water needs space."

The Netherlands learned such lessons by trial and error over the centuries. To a far greater extent than in the United States, citizens' lives depend on flood defenses. Studies show that without its elaborate network of flood control structures, 65 percent of the country would be underwater.

The Dutch Ministry of Water, Public Works and Transportation spends \$1.5 billion a year on flood defense and water management. If the United States spent that much on a per-citizen basis, it would cost upward of \$30 billion annually, seven or eight times the Corps of Engineers' annual budget of \$4 billion.

Sinking and sinking

The country's most densely populated region is built on what used to be low-lying marshes. Three rivers flow out to the North Sea through the Netherlands: the Rhine, the Meuse and the Schelde. For millennia the western part of the country consisted of estuaries and peat bogs repeatedly reshaped by floods and tides.

But somehow the forebears of today's Dutch settled these areas, leading a precarious existence on natural or man-made ridges.

"There the ocean throws itself, two times a day, daily and nightly, in a tremendous stream over a wide country, so one doubts if the ground belongs to the land or to the sea," wrote Roman philosopher Pliny the Elder, who as a soldier in the first century A.D. helped construct a canal in what would become the Netherlands. "There lives a

miserable people at the highest known levels of the tide and here they have built their huts, living like sailors when the water covers their environment and as if shipwrecked when the water has gone. "

Around 1000 A.D., Europe's population swelled and farming expanded. The Dutch began to use limited technologies and their own ingenuity to drain the swamps and keep them dry. Over the centuries, the tools grew more sophisticated and more and more polders - drained areas ringed by dikes - were created.

But draining peat bogs has one major drawback: They sink. Peat and clay soils contract when drained. The lower they get, the more susceptible they become to floods. The increased flooding in turn made people dig their drainage ditches and canals ever deeper, a vicious cycle that continues today. The problem, compounded by the loss of silting from rivers now controlled by dikes, is similar to the subsidence plaguing the New Orleans area.

Combined with gradually rising seas, the change is shocking. In 900, the Netherlands averaged more than 12 feet above sea level. By 1500, it had dropped even with the sea.

Today, it averages 8 feet below sea level and is still dropping at the rate of a quarter inch each year.

Battles won by the sea

Holland's struggle with the sea has shaped its history, and every six generations or so has been marked by a terrible defeat, a catastrophic flood that has swept over swaths of the country, destroying dikes, homes, property and human lives. The Dutch landscape is dotted with reminders of past floods and the measures taken to ensure such a disaster would never happen again.

The only thing left of Koudekerke, a village overlooking an estuary of the Schelde, is the Plompe Toren, a brick church tower that casts a lonely silhouette over nearby farms. A 16th-century flood swept away 13 villages, Koudekerke among them. The tower was all that remained. Later rebuilt, it was leveled again during World War II and permanently abandoned. A recording in the tower tells the legend of a merman who cursed fishermen from the village for catching his wife.

Visible to the east is a breached dike from the 1953 flood that was never repaired - authorities instead opted to rebuild farther back from the water. The area behind the breach is now a marsh. Visible to the west is the enormous Eastern Schelde storm barrier that blocks North Sea surges from the estuary.

Completed in 1986, as part of \$14.7 billion in post-1953 improvements, the Eastern Schelde barrier is a monument to the Netherlands' innovative approach to flood control and includes features the corps is looking at for New Orleans.

Shortening the defenses

For centuries, the Dutch protected themselves by ringing settled areas and farmland with dikes, essentially the same approach used in south Louisiana. But the 1953 flood

revealed a big weakness in that strategy: Storm surge water could move far inland through the estuaries, which were open to the sea.

This was also a key failing of the New Orleans system, Battjes and other Dutch engineers say: The region's levee-lined canals were conduits for Katrina's storm surge to pour into the heart of the city. From the east, water flowed into the Intracoastal Waterway and Industrial Canal, where floodwalls were topped and then collapsed, flooding the Lower 9th Ward, St. Bernard Parish and eastern New Orleans. From Lake Pontchartrain, it flowed into the 17th Street and London Avenue drainage canals, which were breached, flooding central New Orleans.

In the wake of the 1953 flood, engineers and policy-makers presented the Netherlands with a choice: They could build dikes higher and stronger as they had always done in the past. Or they could take a different, more ambitious approach, building large barriers across estuaries and other open waterways.

The second option had one crucial advantage: It would effectively shorten the country's tortuously long coastline by hundreds of miles. If the length of the country's defensive barrier shrank, the thinking went, so would the chance that a dike might fail at some unnoticed weak point and lead to a larger catastrophe. Many miles of older dikes would become secondary, backup protections.

"It's much more logical to shorten your line of defense, " said Battjes, the retired engineering professor, who advised the new system's designers. "To make a military analogy, the water is the enemy. You don't let the enemy, before the fight starts, penetrate your territory. "

Installing surge gates

American engineers have begun looking at how to address this problem in a Category 5 design. One solution would be to put floodgates on some canals. Another would be to retool New Orleans' generations-old stormwater drainage system and move pump stations from the middle of town to the lakefront.

On a more ambitious scale, some officials suggest upgrading an old proposal to build a large levee and floodgate system across the marshes to block surges from entering the Chef Menteur and Rigolets passes into the lake. An early version of the plan was abandoned after environmentalists raised questions about impacts on marshlands.

The Netherlands example provides a template for how to go about this. Early Delta Works plans called for dams to be constructed across all the region's estuaries - just as the government had dammed off a 20-mile opening along the northern coastline in 1933, creating a giant freshwater lake. But by the 1970s, environmentalists, commercial fishing organizations and other groups were complaining that the completed dams were ruining the region's ecology.

They sparked a national debate and eventually a compromise, one that balanced storm defenses against harm to the environment.

The largest result of the change is the enormous Eastern Schelde storm surge barrier, a massive series of 62 floodgates snaking across the water. The gates, which range from

19 to 29 feet high, depending on their position on the barrier, are left open most of the time to allow tidal flows in and out, preserving the estuary behind it. When the high-water alarm sounds - as it has on average twice a year since it opened - the gates are shut until the danger passes.

Thinking big from start

As a reminder of why the barrier is there, the height of the 1953 flood - about 13 feet - is marked by a thick red line at a point along the barrier's southern endpoint.

That reminder is also imbedded in the design DNA of every flood protection project in the country in the form of very high, legally mandated safety standards - something New Orleans most assuredly did not have.

The biggest flaw of New Orleans' pre-Katrina levee system was that it provided a low level of safety: It was built only to withstand storm surges from some, but not all, Category 3 hurricanes and was virtually guaranteed to fail in a stronger storm. In retrospect, engineers say it didn't even live up to its Category 3 billing. In fact, no one knew precisely what level of safety it provided because of its many weak points, changes in the landscape over time and the corps' outdated assessments.

Such problems are inconceivable in the Netherlands. Urbanized areas of the country - such as the region surrounding Ter Heijde, which includes The Hague and Rotterdam - are engineered to withstand the kind of storm surge that comes only once in 10,000 years. More sparsely populated areas, such as those protected by the Delta Works, are safe against a 1-in-4,000-year flood. The lowest level of protection, found in rural areas, is for a 1-in-1,250-year flood. All are many times safer than New Orleans ever was.

Feeling safer

Those numbers are more than risk calculations. In a sense, they're as much the bedrock of the nation's flood security as any dike or barrier. Everybody knows those numbers. They reassure citizens, many of whom now take sound flood protection for granted.

"We feel safe - nobody is afraid. Nobody's thinking, when is the water coming? " said Andre van der Beek, a home care worker in Nieuw-Lekkerland, who paused from riding his bike near a line of 200-year-old windmills and two pumping stations, all built to keep water levels down. "There are a lot of believers here, and they believe the story of Noah, that God promised in Genesis there would not be another flood. "

But the water is still rising, and the land is sinking, and because of those changes in the landscape, Dutch officials say that some dikes and other parts of the system no longer meet the standards. So they are giving the whole thing a top-to-bottom review to identify emerging weaknesses. Vigilance, they say, must be eternal.

"We are not going to allow the level of protection to decrease, " said Marion Smit, the Water and Transportation Ministry's top water policy official.

Achieving that long-term resoluteness might prove to be the single greatest challenge facing New Orleans. Flood control is a national religion in the Netherlands. In 49 U.S. states, it's Louisiana's problem.